TRMM and Other Data Precipitation Data Set Documentation

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Last Year of News

1 July 2009 A processing error that bypassed some IR data in the 00 UTC dataset was corrected and all 3B42 and 3B43 datasets were recomputed and reposted for June 2008 – April 2009. Also, the anomaly in the PR instrument in late May was resolved in mid-June, but recalibration efforts by the PR team will prevent release of the PR data until early August. Accordingly, 3B42 and 3B43 processing will be held until this work is complete.

5 September 2008 The last recorder on board the DMSP F14 failed late on 23 August 2008, effectively ending its SSM/I data record.

28 December 2007 A satellite commanding error for Aqua led to loss of AMSR-E data for the period 03 UTC 27 November to 09 UTC 28 November 2007. Recovery from this problem and two subsequent issues during December all affected the RT system, but were recoverable and resolved by the time the Version 6 products were computed.

26 November 2007 Revised announcement: The team regrets to announce that processing glitches were discovered to have degraded the calibration and data availability for Version 6 3B42 and 3B43 for the month of January 2005, affecting the data distributed by the GDISC, TSDIS, and TOVAS. Revised estimates for January 2005 were posted in the GDISC in early January 2007. Users must discard results that include the original Version 6 January 2005 data, that is, data pulled before mid-January 2007, and re-pull the updated data files. The original, incorrect data continued to be used in TOVAS until 16 November 2007, so January 2005 analyses using 3B42 in TOVAS before 16 November 2007 are similarly not to be trusted. If in doubt, we advise users to pull a sample file and compare it to the one they already have.

31 May 2007 NESDIS upgraded the AMSU-B precipitation algorithm, creating results sufficiently different from previous estimates that 3B42 and 3B43 are given the version number 6a starting with May 2007.

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1. Data Set Names and General Content

The formal **data set name** is the "TRMM and Other Data Precipitation Data Set." The algorithm applied is the TRMM Multi-Satellite Precipitation Analysis. For convenience, it is referred to in this document as the "TMPA." Note that there are other products in the general TRMM processing system.

The data set currently contains two products, three-hourly combined microwave-IR estimates (with gauge adjustment) and monthly combined microwave-IR-gauge estimates of precipitation computed on quasi-global grids about two weeks after the end of each month starting in January 1998.

Huffman et al. (2007) is the primary refereed citation for the TMPA, while this documentation is the primary source of technical information. Huffman et al. (2003) and Huffman et al. (2005) provide earlier short formal summaries (all references are listed in section 13).

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2. Related Projects, Data Networks, and Data Sets

The **data set creators** are G.J. Huffman, R.F. Adler, and D.T. Bolvin, working in the Laboratory for Atmospheres, NASA Goddard Space Flight Center, Code 613.1, Greenbelt, Maryland, 20771 USA, and E.F. Stocker, working in the TRMM Science Data and Information System, NASA Goddard Space Flight Center, Code 610.2, Greenbelt, Maryland, 20771 USA.

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The work is being carried out as part of the Tropical Rainfall Measuring Mission (**TRMM**), an international project of NASA and JAXA designed to provide improved estimates of precipitation in the Tropics, where the bulk of the Earth's rainfall occurs. The TRMM home page is located at *http://trmm.gsfc.nasa.gov/* .

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The TMPA draws on data from several **data providers**:

1. NASA/GSFC level 1 PR reflectivities,
2. NASA/GSFC level 1 TMI Tb's (processed with TRMM algorithm 2A12 at TSDIS),
3. NASA/GSFC level 2 PR-TMI "tall vector" precipitation estimates (processed with TRMM algorithm 2A31 at TSDIS),
4. NASA/GSFC Level 1b AMSR-E Tb's (processed with GPROF-AMSR at TSDIS),
5. RSS SSM/I Tb's (processed with GPROF-SSMI at TSDIS),
6. NESDIS operational level 2 AMSU-B precipitation estimates,
7. NOAA/NWS/CPC IR Tb Histogram Data (processed into VAR at TSDIS),
8. NOAA/NWS/CPC Merged 4-Km Geostationary Satellite IR Brightness Temperature Data (processed into VAR at TSDIS),
9. GPCC Monitoring Precipitation Gauge Analysis, and
10. NOAA/NWS/CPC CAMS Precipitation Gauge Analysis.

These data sets extend beyond the TMPA period in their original archival locations.

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There are numerous **similar data sets**, although no other matches all the attributes of being routinely produced, publicly available, fine-scale in space and time, quasi-global, available from January 1998 onwards, intercalibrated, and formed by combining multiple data sources including precipitation gauges. The closest include the set of estimates based on:

1. Turk (1999), which uses individual SSM/I overpasses to calibrate geo-IR precipitation estimates;

2. Sorooshian et al. (2000), which applies the PERSIANN neural network to calibrate IR with microwave; and
3. Joyce et al. (2004), which applies the CMORPH morphing scheme to time-interpolate microwave patterns with IR-based motion vectors.

Several SSM/I-based data sets are available as gridded single-sensor data sets with significant data voids in cold-land, snow-covered, and ice-covered areas, including those computed with the GPROF 6.0 and 2004a algorithms (based on Kummerow et al. 1996) and the NOAA Scattering algorithm (Grody 1991), among others. Other daily, single-sensor data sets are available for open-water regions based on SSM/I data (Wentz and Spencer 1998), MSU data (Spencer 1993), AMSR-E, and AMSU-B data. Numerous daily single-sensor or combination data sets are available at the regional scale, but are not really "similar."

The Real-Time TRMM product 3B42RT is being computed with the TMPA-RT in near-real time, and constitutes the most timely source of TMPA estimates. See "3B42RT" for details.
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The Version 6 TRMM product **3B42RT** is being computed with the TMPA in near-real time, and constitutes the most timely source of TMPA estimates. The near-real time computation requires several simplifications in 3B42RT compared to 3B42:

1. The complete 3B42RT data record is not reprocessed as upgrades are made to the procedure – its main focus is timeliness.
2. The IR calibration period is a trailing 30-day accumulation, rather than the calendar month in which the observation time falls.
3. A real-time version of the TMI is used as the calibrating standard because the TRMM Combined Instrument product (2B31) is not available in real time.
4. In near-real time it is not possible to apply precipitation gauge data.

Note that 3B42 estimates are considered to supersede the 3B42RT estimates as each month of 3B42 is computed, during the following month. The 3B42 processing is designed to maximize data quality, so 3B42 is strongly recommended for any research work not specifically focused on real-time applications.

Both 3B42RT and 3B42 were upgraded to include AMSR-E and AMSU-B precipitation estimates in late 2004. The new version of 3B4XRT began operational use at 08Z 3 February 2005, and current-data processing for Version 6 3B42/43 began in July 2005. The entire available archive of AMSR-E and AMSU-B estimates is incorporated in the Version 6 3B42. As well, the reprocessed record of CPC Merged 4-Km IR Tb data through December 2001 is included in the Version 6 3B42. Eventually CPC will reprocess through November 2002, but the changes after December 2001 are not significant to 3B42.
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3. Storage and Distribution Media

The **data set archive** consists of Hierarchical Data Files (HDF). Each 3-hour dataset (3B42) or monthly dataset (3B43) is contained in a separate file with standard self-documenting HDF metadata. The 3B42/3B43 data are distributed via the Internet. Each file is approximately 5 MB (uncompressed).

The full collection of 3B42/3B43 files are provided and archived by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC) located at *http://disc.gsfc.nasa.gov*. Other independent sources of these data exist, but it is highly recommended that users only access the data via the GES DISC as it always has the latest versions of 3B42 and 3B43.

Web-based interactive access to these and related data is provided through the TOVAS; see that topic for details.
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The TRMM Online Visualization and Analysis System (**TOVAS**) is created and supported by the Goddard Earth Sciences Data and Information Services Center (GES DISC). It provides a web-based resource for accessing 3B42 and several other data sets, performing basic subsetting, time- and space-averaging, and output of results in plots or ASCII text. The TOVAS URL is *http://disc2.nascom.nasa.gov/Giovanni/tovas/* .
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4. Reading the Data

The **data file layout** and **data file access technique** details are provided for 3B42 and 3B43 at

http://disc.gsfc.nasa.gov/precipitation/TRMM_README/TRMM_3B42_readme.shtml

and

http://disc.gsfc.nasa.gov/precipitation/TRMM_README/TRMM_3B43_readme.shtml,

respectively.
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It is possible to **read a file of data** with many standard data-display tools. Any tool that reads the standard HDF file can be used to process 3B42 and 3B43 files. Alternatively, TSDIS provides a toolkit with C and FORTRAN versions that allow users to write custom programs. See *http://tsdis.gsfc.nasa.gov/tsdis/Documents/Tutorial.pdf* for more details
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5. Definitions and Defining Algorithms

The **time zone** for this data set is Universal Coordinated Time (UTC, also as GMT or Z).

Because the data are provided at nominal UTC hours, each 3B42 data set represents a nominal +/-90-minute span around the nominal hour. Thus, the 00Z images include data from the very end of the previous UTC day.
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The *IR Tb histogram data set* is produced by the Geostationary Satellite Precipitation Data Centre (GSPDC) of the GPCP under the direction of J. Janowiak, located in the Climate Prediction Center, NOAA National Centers for Environmental Prediction, Washington, DC, 20233 USA. Each cooperating geostationary (geo) satellite operator (the Geosynchronous Operational Environmental Satellites, or GOES, United States; the Geosynchronous Meteorological Satellite, or GMS, Japan; and the Meteorological Satellite, or Meteosat, European Community) accumulates three-hourly infrared (IR) imagery. These are forwarded to GSPDC as 24-class histograms of Tb on a 1°x1° lat./lon. grid. The global geo-IR are then merged on a global grid covering 40°N-S. In parallel, the NOAA-series low-earth-orbit (leo) satellite operator (United States) provides GPI values on a 1°x1° lat./lon.grid accumulated to the nearest 3-hrly time.

These data are used as input to TMPA processing before the start of Merged 4-Km IR Tb data, currently reprocessed to start 7 February 2000. Before use, each grid box's histogram in the 1°x1° 3-hourly 40°N-S IR Tb histogram dataset is zenith-angle corrected, averaged to a single Tb value for the grid box, and plane-fit interpolated to the 0.25° grid.
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The *Merged 4-Km IR Tb data set* is produced by the Climate Prediction Center (CPC), NOAA National Centers for Environmental Prediction, Washington, DC, 20233 USA under the direction of J. Janowiak. Each cooperating geostationary (geo) satellite operator (the Geosynchronous Operational Environmental Satellites, or GOES, United States; the Geosynchronous Meteorological Satellite, or GMS, Japan; and the Meteorological Satellite, or Meteosat, European Community) forwards infrared (IR) imagery to CPC. Then global geo-IR are zenith-angle corrected (Joyce et al. 2001), re-navigated for parallax, and merged on a global grid. In the event of duplicate data in a grid box, the value with the smaller zenith angle is taken. The data are provided on a 4-km-equivalent grid over the latitude band 60°N-S, with a total grid size of 9896x3298.

The data set was first produced in late 1999. A series of processing upgrades were introduced in the first three years, but none were critical to the TMPA-RT during its period of record starting February 2002. CPC is using the code in place since November 2002 to systematically reprocess their entire data set from January 2000 (the start of their digital archive of input data), and these data are being used in the Version 6 3B42. Due to reprocessing schedules, TSDIS reprocessing overtook CPC reprocessing, so Version 6 uses the original CPC archive after December 2001. However, as noted above, the differences are small in this period. After the current reprocess is done, CPC will extend the record back to November 1998, planning to finish in Q2 2008.

All 5 geo-IR satellites are used, with essentially continuous coverage during the TMPA-RT period of record. GMS-5 was replaced by GOES-9 starting 01Z 22 May 2003, which introduced slightly different instrument characteristics, and then starting 19Z 17 November 2005 the new

Japanese MTSat-1R took over. The associated format change prevented use of the new MTSat-1R data by CPC, and consequently provoked a loss of coverage in the GMS sector in the period 19Z 17 November 2005 to 09Z 23 March 2006 for the RT (and to 00Z 23 March 2006 for Version 6). Data from adjacent geo-IR satellites partially fills this shortfall.

Each UTC hour file contains 2 data fields. All geo-IR images with start times within 15 minutes of the UTC hour are accumulated in the "on-hour" field. Images with start times within 15 minutes of the UTC hour plus 30 minutes are accumulated in the "half-hour" field. The nominal image start times for the various satellites and their assignment to half-hour fields are shown in Table 1.

Table 1. Nominal sub-satellite longitude (in degrees longitude) and image start time (in minutes past the hour) for the various geosynchronous satellites. The start times are displayed according to their assignment to either the on-hour or half-hour fields in the CPC Merged 4-Km IR Tb data set. Full-disc views are guaranteed only at 00Z, 03Z, ..., 21Z. These appear in the on-hour field except MTSat appears in the previous half-hour for all hours. For images not at these times, a satellite's "image" may be assembled from various operator-specified regional sectors. MTSat provides N. Hemisphere sectors (only) on-hour, except S. Hemisphere sectors (only) at 00Z, 06Z, 12Z, 18Z.

Satellite	*Sub-sat. Lon.*	*on-hour*	*half-hour*
MTSat-1R (old GMS)	140E	00	30
GOES-E (8, now 12)	75W	45	15
GOES-W (10, now 11)	135W	00	30
Meteosat-8 (old 7)	0E	00	30
Meteosat-5	63E	00	30

These data are used as input to TMPA processing.
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The Goddard Profiling Algorithm (*GPROF*) is based on Kummerow et al. (1996) and Olson et al. (1999). GPROF is a multi-channel physical approach for retrieving rainfall and vertical structure information from satellite-based passive microwave observations (here, TMI, AMSR-E, and SSM/I). The GPROF-AMSR and GPROF-SSM/I estimates are computed from the respective Tb's as part of the TMPA-RT, while the GPROF-TMI estimates are computed by TSDIS as 2A12. The current version applies a Bayesian inversion method to the observed microwave brightness temperatures using an extensive library of cloud-model-based relations between hydrometeor profiles and microwave brightness temperatures. Each hydrometeor profile is associated with a surface precipitation rate. GPROF includes a procedure that accounts for inhomogeneities of the rainfall within the satellite field of view. Over land and coastal surface areas the algorithm reduces to a scattering-type procedure using only the higher-frequency channels. This loss of information arises from the physics of the emission signal in the lower frequencies when the underlying surface is other than all water.

The respective versions of this algorithm are applied to the TMI, AMSR-E, and SSM/I Tb data, and the estimates are used as input to TMPA processing. The TMI estimates were computed using GPROF-TMI Version 6. All AMSR-E estimates have been computed using Version 1 of

GPROF-AMSR. The SSM/I estimates are computed using GPROF-SSM/I Version 6.5 - the "old" Version 6 ocean algorithm with the "new" Version 7 land.
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TSDIS algorithm **2A12** contains level 2 (scan-pixel) GPROF estimates of precipitation based on TMI data. These are provided by TSDIS. Each file contains an orbit of estimates. The data have had some quality control, and are converted from sensor units to Ta, then to Tb, then to precipitation.

These data are used as input to TMPA processing.
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SSM/I Level 2 Ta data are those produced by Remote Sensing Systems, Inc. (RSS) of Santa Rosa, CA, as Version 4.

These data are used as input to GPROF-SSM/I for use in TMPA processing. In use, the Ta's are converted to Tb's using the RSS DECODE4 routine.

Starting with January 2005 the RSS Tb's were downloaded directly, then on 12 September 2006 we changed to using RSS Version 4 Tb's.

Note that the TMPA-RT uses a different source of SSM/I Ta data.
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TSDIS algorithm **2B31** contains level 2 (scan-pixel) output from the combined PR-TMI retrieval algorithm, computed at TSDIS. The TRMM combined algorithm (2B31) combines data from the TMI and PR to produce the best rain estimate for TRMM. Currently, it uses the low frequency channels of TMI to find the total path attenuation. This information is used to constrain the radar equation. Each file contains an orbit of Combined PR/TMI rain rate and path-integrated attenuation at 4 km horizontal and 250 m vertical resolutions over a 220 km swath. More information is available at

http://disc.gsfc.nasa.gov/precipitation/TRMM_README/TRMM_2B31_readme.shtml

and Haddad et al. (1997a,b).

These data are used as input to TMPA processing.
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The **AMSU-B precipitation data set** is computed operationally at the National Environmental Satellite Data and Information Service (NESDIS) based on the Zhao and Weng (2002) and Weng et al. (2003) algorithm. Ice Water Path (IWP) is computed from the 89- and 150-GHz channels, with a surface screening that employs Advanced Very High Resolution Radiometer (AVHRR) infrared data and Global Data Assimilation System (GDAS) surface temperature and surface type data to discriminate desert, snowy, or icy surfaces. Precipitation rate is then computed based on the IWP and precipitation rate relations derived from cloud model data computed with the NCAR/PSU Mesoscale Model Version 5 (MM5). The precipitation rate is approximated as a second-degree polynomial in IWP, with coefficients that are derived separately for weak-to-moderate and strong events, as classified by comparing the three AMSU-B 183-GHz channels. The maximum precipitation rate allowed is 30 mm/hr. The AMSU-B algorithm can discriminate between precipitating and non-precipitating ice-bearing clouds, but cannot provide information on precipitation systems that lack the ice phase.

The **AMSU-B precipitation data set** is computed operationally at the National Environmental Satellite Data and Information Service (NESDIS) based on the Zhao and Weng (2002) and Weng et al. (2003) algorithm. Ice water path (IWP) and particle effective diameter size (De) are computed from the 89 and 150 GHz channels. As such, it is a primarily a scattering approach. Surface screening is carried out using Advanced Very High Resolution Radiometer (AVHRR) infrared data and Global Data Assimilation System (GDAS) surface temperature and surface type data to discriminate desert, snowy, or icy surfaces. Precipitation rate is computed based on IWP–precipitation rate relations derived from the NCAR/PSU Mesoscale Model Version 5 (MM5). The precipitation rate is approximated as a second-degree polynomial in IWP, with coefficients that are derived separately for convective and non-convective situations, based upon a series of comparisons between the three AMSU-B channels centered at the 183.31 GHz water vapor absorption band. Additionally, the algorithm identifies regions of falling snow over land through the use of AMSU-A measurements at 53.8 GHz. At present, falling snow is assigned a rate of 0.1 mm/hr, although an experimental snowfall rate is being tested and evaluated.

The data set was first produced in early 2000. The algorithm was upgraded on 31 July 2003 and again on 31 May 2007. In the later, an emission component was added to increase the areal coverage of rainfall over oceans through the use of a liquid water estimation using AMSU-A 23.8 and 31 GHz (Vila et al. 20007). Additionally, an improved coastline rainrate module was added that computes a proxy IWP using the 183 GHz bands (Kongoli et al. 2007). The first upgrade did not affect the TMPA-RT because it only started using AMSU-B estimates on 3 February 2005, but the second did. [NESDIS did not reprocess the prior AMSU-B data set in the first upgrade, but it did in the second. The Version 6 3B42 reprocessing carried out at the start of Version 6 for 3B42/43 occurred before the full reprocessing associated with the second AMSU-B upgrade, so 3B42 had to account for two different AMSU-B epochs. When NESDIS did reprocess the full AMSU-B record, Version 6 was frozen. Thus, yet a third set of AMSU-B inter-satellite calibrations was introduced in 3B42 to account for changed behavior in the second AMSU-B upgrade, and the version number for 3B42 and 3B43 was set to 6a for subsequent months.]

The level 2 version of these data are used as input to TMPA processing.

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The High Quality (**HQ**) combined microwave precipitation estimate provides a global 0.25°x0.25° -averaged 3-hourly combination of all currently available estimates - TCI, TMI, SSM/I, AMSR-E, and AMSU-B:

1. Offline, the GPROF-SSM/I, GPROF-AMSR, and AMSU-B have been probability-matched to 2A12. The calibrations of AMSU-B and AMSR-E to TMI each have one set of

coefficients for land and a separate set for ocean, while SSM/I uses one set for land and 5 for ocean, covering the latitude bands 90-30°S, 30-10°S, 10°S-N, 10-30°N, and 30-90°N. AMSR-E uses a 2-month set of match-ups to ensure sufficient sampling, while all of the others work with single-month accumulations. The AMSR-E and AMSU-B coefficients apply to the entire year, while SSM/I uses a separate set for each season.

2. The GPROF-SSM/I, GPROF-AMSR, AMSU-B, 2A12, 2A25, and 2B31 estimates are gridded to a 0.25°x0.25° grid for a 3-hour period centered on the major synoptic times (00Z, 03Z, ..., 21Z).
3. The GPROF-SSM/I, GPROF-AMSR, and AMSU-B estimates are calibrated to 2A12.
4. The 2A12 is calibrated to the 2B31 using a monthly-computed matched histogram correction. The correction is computed and applied at the 1° resolution since the 2A12 and 2B31 estimates vary significantly by region and time of year.
5. The 2A12-calibrated GPROF-SSM/I, GPROF-AMSR, and AMSU-B estimates are calibrated to 2B31 using the same method as in the 2B31/2A12 adjustment scheme.
6. The rain rate in each grid box is the pixel-weighted average of 2B31, if available in the 3-hour window, or the pixel-weighted average of the calibrated conical-scan microwave radiometer estimates (2A12, GPROF-SSM/I, and GPROF-AMSR) contributing during the 3 hours, or the pixel-weighted average of AMSU-B estimates if no other HQ estimates are available.
7. Additional fields in the data file include the number of pixels, the number of pixels with non-zero rain, and the number of pixels for which the estimate is "ambiguous," or highly uncertain.
8. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

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The Variable Rainrate (**VAR*) IR precipitation estimate converts 0.25°x0.25°-averaged geo-IR Tb to rainrates that are HQ-calibrated locally in time and space:

1. Both geo-IR Tb and HQ are averaged to 0.25°x0.25° to ensure consistent spatial scale, and time-space matched data are accumulated over calendar months.
2. In each calibration, the Tb-rainrate curve is set locally by probability matching the month's histograms of coincident IR Tb and HQ rain rate.

The local VAR Tb-rainrate curve is applied to each geo-IR Tb data set in the month:

1. For the Merged 4-Km Tb, over most of the globe the on-hour data field is taken as the input data, with fill-in by the previous half-hour image. The exception is the GMS sector, where the previous half-hour is primary, since GMS does not schedule images on the hour. [In that case, much of the GMS sector is filled with data from METEOSAT5 and GOES-W at very high zenith angles.] For the converted 1°, 3-hourly histograms there is no choice needed.
2. The Tb-to-rainrate conversion is a simple look-up, using whatever set of VAR calibration coefficients is current.
3. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

For the period January 1, 1998 - February 6, 2000, 1°, 3-hourly histograms of IR data were used in the 3B42 processing. This data only covers the region 40°N-S, so the latitude bands 40-50° in each hemisphere are set to missing for the VAR. After February 6, 2000, the 4-km IR is used, which covers the entire region 50°N-S.

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The combination of **HQ+VAR** is computed every 3 hours from that hour's HQ and VAR fields:

1. The present combination scheme is to take the HQ field wherever it is non-missing, and fill in with VAR elsewhere.
2. The additional field in the file is the RMS error of the estimate.
3. The VAR estimates are only posted for the latitude band 50°N-S.
4. It is planned to do a more sophisticated combination in a future release.
5. Following the computation of the monthly SG combination (see that topic for details), in each grid box all of the available 3-hourly HQ+VAR values are scaled to sum to the monthly SG value.
6. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

For the period January 1, 1998 - February 6, 2000, 1°, 3-hourly histograms of IR data were used in the 3B42 processing. This data only covers the region 40°N-S, so the latitude bands 40-50° in each hemisphere contain only HQ estimates. After February 6, 2000, the 4-km IR is used, which covers the entire region 50°N-S.

These data are output as 3B42 in TMPA processing.

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3B42 is the official TSDIS identifier of the HQ+VAR data set. The identifier indicates that it is a level 3 (gridded) product with input from multiple sensors ("B") using non-TRMM data ("40"-series).

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The monthly satellite-gauge, or **SG combination** is computed as follows:

1. The original (i.e., before the scaling step) 3-hourly HQ+VAR estimates are summed for the calendar month.
2. The monthly precipitation gauge analysis is used to create a large-scale bias adjustment to these satellite-only estimates in regions where the gauge stations are available, mostly land. Note that analysis values distant from any gauges are not used.
3. The monthly gauge-adjusted satellite-only estimate is combined directly with the precipitation gauge analysis using inverse error variance weighting.

These data are output as 3B43 in TMPA processing.

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3B43 is the official TSDIS identifier of the satellite-gauge, or SG combination data set. The identifier indicates that it is a level 3 (gridded) product with input from multiple sensors ("B") using non-TRMM data ("40"-series).
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The *units of the TMPA estimates* are mm/hour for the precipitation and random error estimates. The HQ+VAR (3B42) precipitation value is best thought of as an instantaneous rate, valid at the nominal observation time, while the SG combination (3B43) precipitation value is an average rate over the month.
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6. Temporal and Spatial Coverage and Resolution

The *file date* is the UTC year, month, day in which the nominal time of the data set occurs. All dates are UTC.
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The *temporal resolution* of the products is:
- HQ+VAR (3B42): 3 hr
- SG (3B43): monthly

The 3-hour period for the HQ+VAR (3B42) is driven by the need for the HQ to accumulate a reasonable sample without encompassing too large a fraction of the diurnal cycle. Note that both the microwave and IR data are instantaneous, except for small regions in which 2 (or more) overlapping microwave scenes are averaged in the HQ field. This is done to make the statistics of the data sets as comparable as possible. The precipitation value is best thought of as an instantaneous rate, valid at the nominal observation time. It is not an accumulation. As such, it applies to the 3-hour window centered on the nominal time, i.e., covering the span 90 minutes on either side of the nominal time.

The monthly period for the SG (3B43) is driven by the typical monthly period of precipitation gauge analyses, although it is also a typical period requested by many users. The precipitation value is an average over the month.
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The *period of record* for the TMPA is January 1998 through the present, with a delay of about two weeks after the end of the month for processing. The start is based on the first full month of TRMM data. The real-time TRMM product 3B42RT provides real-time processing of the TMPA from late January 2002 to the present. See "3B42RT" for more details.
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The *grid* on which each field of values is presented is a 0.25°x0.25° lat./lon. (Cylindrical Equal Distance) global array of points. It is size 1440x400, with X (longitude) incrementing most rapidly West to East from the Dateline, and then Y (latitude) incrementing South to North from the southern edge. Quarter-degree latitude and longitude values are at grid edges:
First point center (49.875°S,179.875°W)

Second point center (49.875°S,179.625°W)
Last point center (49.875°N,179.875°E)
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The **spatial resolution** of the products is 0.25°x0.25° lat/lon.
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The **spatial coverage** of the products is 50°N-S.
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7. Production and Updates

Production and updates for the TMPA are a joint activity of the precipitation research group in NASA Goddard Space Flight Center in the Laboratory for Atmospheres and TSDIS.

The latency of the products after the month is governed by the latency of the individual input products. At this time the pacing item is the delivery of the gauge analysis. Once initiated, the processing occurs in a matter of minutes.

Updates will be released to (1) extend the data record, (2) take advantage of improved combination techniques, or (3) correct errors. Updates resulting from the last two cases will be given new version numbers.

> NOTE: The changes described in this section are typical of the changes that are required to keep the TMPA abreast of current requirements and science. Users are strongly encouraged to check back routinely for additional upgrades and to refer other users to this site rather than redistributing data that are potentially out of date.

Two events in late summer 2006 reduced the microwave data content in 3B42 (and 3B43). First, on 14 August 2006 DoD activated a radar calibration beacon on the F15 SSM/I that interferes with the 22V channel and effectively prevents reliable estimates with the current version of GPROF. Second, AMSR-E dropped out starting 5 September, first due to access issues, and then to a hardware failure at the AMSR-E data provider machine. GPROF is being modified to utilize data from the F16 SSM/IS follow-on to F15 and/or from F15. A temporary fix to the AMSR-E feed has been made; AMSR-E is absent from the products for the data times 12Z 07 September to 03Z 11 September 2006.

On 15 November 2007 the January 2005 datasets for 3B42 and 3B43 were replaced. It had been discovered that processing glitches caused serious issues with IR calibration and microwave data availability. No results computed with the original January 2005 3B42 or 3B43 data should be considered reliable.

In the future, all products will be provided with random error estimates.
....

8. Sensors

The TRMM Precipitation Radar (**PR**) is a flat-panel phased-array weather radar, the first flown in space, that has flown on TRMM since December 1997. TRMM is placed in a (46-day) precessing orbit at a 35° inclination with a period of about 91.5 min. The horizontal and vertical resolutions are 4 km and 250 m, respectively, over a 220 km swath to a height above sea level of 20 km. The minimum detectable signal is 17 (18) dBZ before (after) the TRMM orbit boost in August 2001.

The PR is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. There were outages for an operational anomaly in May 2000, and the boost to a higher orbit during the first part of August 2001.

The 35° inclination provides nominal coverage over the latitudes 37°N-S, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land or sea ice (if there happened to be any).

Further details are available in Kummerow et al. (1998).
....

The TRMM Microwave Imager (**TMI**) is a multi-channel passive microwave radiometer that has flown on TRMM since December 1997. TRMM is placed in a (46-day) precessing orbit at a 35° inclination with a period of about 91.5 min. The channels have effective fields of view that vary from 4.6x6.9 km for the 85 GHz (oval due to the slanted viewing angle) to 29.1x55.2 km for the 10 GHz. Consequently, the 85 GHz is undersampled, and all other channels are more or less oversampled.

The TMI is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. There were outages for an operational anomaly in May 2000, and the boost to a higher orbit during the first part of August 2001.

The 35° inclination provides nominal coverage over the latitudes 40°N-S, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land or sea ice (if there happened to be any).

Further details are available in Kummerow et al. (1998).
....

The Advanced Microwave Scanning Radiometer for the Earth Observing System (**AMSR-E**) is a multi-channel passive microwave radiometer provided by the Japan Aerospace Exploration Agency that has flown on Aqua since mid-2003. Aqua is placed in a sun-synchronous polar orbit with a period of about 102 min. The AMSR-E provides vertical and horizontal polarization values for 6, 10, 18, 23, 36, and 89 GHz frequencies (except only vertical at 23) with conical scanning, similar to the SSM/I. Pixels and scans are spaced 10 km apart at the suborbital point, except the 85-GHz channels are collected at 5 km spacing. Every other high-frequency pixel is co-located with the low-frequency pixels, starting with the first pixel in the scan and the first scan in a pair of scans. The channels have resolutions that vary from 4x6 km for the 89 GHz (oval due to the slanted viewing angle) to 43x74 km for the 6 GHz.

The polar orbit provides nominal coverage over the latitudes 85°N-S, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land or sea ice.

The AMSR-E is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. Over time the coverage has improved as the operational system has matured. As well, the B-scan sensor, which provides the 89 GHz scan between the lower-frequency scans, failed around 4 November 2004.

Further details are available at *http://www.ghcc.msfc.nasa.gov/AMSR/*.
....

The Special Sensor Microwave/Imager (**SSM/I**) is a multi-channel passive microwave radiometer that has flown on selected Defense Meteorological Satellite Program (DMSP) platforms since mid-1987. The DMSP is placed in a sun-synchronous polar orbit with a period of about 102 min. The SSM/I provides vertical and horizontal polarization values for 19, 22, 37, and 85 GHz frequencies (except only vertical at 22) with conical scanning. Pixels and scans are spaced 25 km apart at the suborbital point, except the 85-GHz channels are collected at 12.5 km spacing. Every other high-frequency pixel is co-located with the low-frequency pixels, starting with the first pixel in the scan and the first scan in a pair of scans. The channels have resolutions that vary from 12.5x15 km for the 85 GHz (oval due to the slanted viewing angle) to 60x75 km for the 19 GHz.

The polar orbit provides nominal coverage over the latitudes 85°N-S, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land or sea ice.

The SSM/I is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. Over time the coverage has improved as the operational system has matured. As well, the first 85 GHz sensor to fly degraded quickly due to inadequate solar shielding. After launch in mid-1987, the 85.5 GHz vertical- and horizontal-polarization channels became unusable in 1989 and 1990, respectively. Another issue arose on 14 August 2006: DoD activated the RADCAL beacon on the F15 DMSP, which interfered with the 22V and 85.5V channels, preventing reliable estimates using current GPROF code.

Further details are available in Hollinger et al. (1987, 1990).

The inventory of SSM/I data used in the TMPA includes:

DMSP	*Period of Record*	*Status*
F13	1 January 1998 - Current	active
F14	1 January 1998 - 23 August 2008	inactive
F15	18 December 1999 - 14 August 2006	active, but unusable

....

The Advanced Microwave Sounding Unit B (*AMSU-B*) is a multi-channel passive microwave radiometer that has flown on selected National Oceanic and Atmospheric Administration (NOAA) platforms since early 2000. The NOAA satellites are placed in sun-synchronous polar orbits with periods of about 102 min. The complete AMSU contains 20 channels, the first 15 referred to as AMSU-A, and the last 5 as AMSU-B. These channels (identified as 16 through 20) cover the frequencies 89.0 +/- 0.9, 150.0 +/- 0.9, and 183.31 +/-1, 3, and 7, all in GHz, with cross-track scanning. Pixels and scans are spaced 16.3 km apart at nadir, with the pixels increasing in size and changing from circular to elongated in the cross-track direction as one moves away from nadir.

The polar orbit provides nominal coverage over the entire globe, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land or sea ice.

The AMSU-B is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. Over time the coverage has improved as the operational system has matured. As well, the NOAA-17 50-GHz channel failed in late October 2003, apparently due to solar flare activity, so this defect affects the entire period of record for the TMPA-RT.

Further details are available in the NOAA KLM User's Guide (September 2000 revision) at *http://www2.ncdc.noaa.gov/docs/klm/index.htm*, specifically at *http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-4.htm* .

The inventory of AMSU-B data used in the TMPA includes:

Satellite	*Period of Record*	*Status*
NOAA-15	1 January 2000 - Current	active
NOAA-16	4 October 2000 - Current	active
NOAA-17	28 June 2002 - Current	active

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The infrared (*IR*) data are collected from a variety of sensors flying on the international constellation of geosynchronous-orbit meteorological satellites – the Geosynchronous Operational Environmental Satellites (GOES, United States), the Geosynchronous Meteorological Satellite (GMS, Japan), and the Meteorological Satellite (Meteosat, European Community). There are usually two GOES platforms active, GOES-EAST and -WEST, which cover the eastern and western United States, respectively. The geosynchronous IR data are collected by scanning (parts of) the earth's disk. By international agreement, all satellite operators collect full-disk images at the synoptic observing times (00Z, 03Z, ..., 21Z) at a minimum.

Subsequent processing is described in “IR Tb Histogram data set” and "Merged 4-Km IR Tb data set".

The various IR instruments are operational sensors, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, sensor failures, etc. Most notably during the TMPA period of record, GMS-5 was replaced by GOES-9 starting 01Z 22 May 2003, which introduced slightly different instrument characteristics. Starting 19Z 17 November 2005 the new MTSat-1R went operational, but NOAA/CPC was unable to process the new format through 09Z 23 March 2006 for the RT (and 00Z 23 March 2006 in Version 6).

Further details are available in Janowiak and Arkin (1991).
....

The **precipitation gauge analysis*, frequently mislabeled "rain gauge analysis", that is used in the TMPA varies according to when the TMPA processing occurs. The GPCP monthly gauge analysis developed by the Global Precipitation Climatological Center (GPCC; Rudolf 1993) is used only in reprocessing because it lags two to three months after observation time due to quality control and data latency. The Climate Assessment and Monitoring System (CAMS) monthly raingauge analysis developed by CPC (Xie and Arkin 1996) is available within two weeks after the end of the month, but it has minimal quality control. In Version 6 of the 3B42/3B43 data set, GPCC was used through March 2005 and CAMS thereafter.

For the GPCC analysis, gauge reports are archived from about 6700 stations around the globe, both from Global Telecommunications Network reports, and from other world-wide or national data collections. An extensive quality-control system is run, featuring an automated step and then a manual step designed to retain legitimate extreme events that characterize precipitation. A variant of the SPHEREMAP spatial interpolation routine (Willmott et al. 1985) is used to analyze station values to area averages.

The CAMS analysis is similarly prepared, but with fewer stations only gross automated error-checking based on station availability.

Both data sets are corrected for climatological estimates of systematic error due to wind effects, side-wetting, evaporation, etc., following Legates (1987).
....

9. Error Detection and Correction

PR error detection/correction has several parts. The performance of the various radar components, including transmit power and Low Noise Amplifiers, are monitored. An active ground calibration target is episodically viewed, and surface Zo is routinely monitored. See *http://tsdis.gsfc.nasa.gov/tsdis/Documents/PR_Manual_JAXA_V6.pdf* for more information.

Accuracies in the radar data are within the uncertainties of the precipitation estimation techniques.

The satellite altitude change in August 2001 introduced some changes in detectability for which the algorithms are supposed to approximately account.
....

TMI error detection/correction is quite similar to that of the SSM/I because it is a modified SSM/I with the 10 GHz channels added. Built-in hot- and cold-load calibration checks are used to convert counts to Antenna Temperature (Ta). An algorithm converts Ta to Brightness Temperature (Tb) for the various channels (eliminating cross-channel leakage). As well, systematic navigation corrections are performed. All pixels with non-physical Tb and local calibration errors are deleted.

Accuracies in the Tb's are within the uncertainties of the precipitation estimation techniques. For the most part, tests show stable cross-calibration with the fleet of SSM/I's.

TRMM is designed to precess over a 46-day period. There is no direct effect on the accuracy of the TMI data, but the continually changing diurnal sampling can cause significant fluctuations in the resulting TMI-only precipitation estimates.

One important test for artifacts is screening the data for "excessive" numbers of "ambiguous pixels"; see that topic for an explanation.
....

AMSR-E error detection/correction has several parts. Built-in hot- and cold-load calibration checks are used to convert counts to Antenna Temperature (Ta). An algorithm has been developed to convert Ta to Brightness Temperature (Tb) for the various channels (eliminating cross-channel leakage). As well, systematic navigation corrections are performed. All pixels with non-physical Tb and local calibration errors are deleted.

Accuracies in the Tb's are within the uncertainties of the precipitation estimation techniques.

One important test for artifacts is screening the data for "excessive" numbers of "ambiguous pixels"; see that topic for an explanation.
....

SSM/I error detection/correction has several parts. Built-in hot- and cold-load calibration checks are used to convert counts to Antenna Temperature (Ta). An algorithm has been developed to convert Ta to Brightness Temperature (Tb) for the various channels (eliminating cross-channel leakage). Differences between the Ta-to-Tb conversions employed by RSS and the U.S. Navy's Fleet Numerical Meteorological and Oceanographic Center imply that uncertainties in the Ta-to-Tb conversion are much larger than any other known uncertainty. As well, systematic navigation corrections are performed. All pixels with non-physical Tb and local calibration errors are deleted.

Accuracies in the Tb's are within the uncertainties of the precipitation estimation techniques. For the most part, tests show only small differences among the SSM/I sensors flying on different platforms.

Some satellites experienced significant drifting of the equator-crossing time during their period of service. There is no direct effect on the accuracy of the SSM/I data, but it is possible that the systematic change in sampling time could introduce biases in the resulting SSM/I-only precipitation estimates.

One important test for artifacts is screening the data for "excessive" numbers of "ambiguous pixels"; see that topic for an explanation.

....

AMSU-B error detection/correction has several parts. Built-in hot- and cold-load calibration checks are used to convert counts to Antenna Temperature (Ta). Systematic navigation corrections are performed. All pixels with non-physical Tb and local calibration errors are deleted.

Accuracies in the Tb's are within the uncertainties of the precipitation estimation techniques. The main difficulty results from the loss of the NOAA-17 50-GHz channel.

Some satellites experienced significant drifting of the equator-crossing time during their period of service. There is no direct effect on the accuracy of the AMSU-B data, but it is possible that the systematic change in sampling time could introduce biases in the resulting AMSU-B-only precipitation estimates.

....

In common with other microwave algorithms, GPROF flags pixels with certain ranges of Tb values as **ambiguous pixels** because such ranges are associated with both real precipitation and artifacts, compared to coincident weather observations. GPROF leaves it to the user to evaluate such pixels for use or deletion. In the TMPA-RT the ambiguous pixels are handled as follows:

1. In the HQ, experience shows that when the fraction of ambiguous (FA) exceeds 40% or the 5x5-grid box average FA exceeds 20%, the precipitation value is likely an artifact.
2. In the calibration for VAR, all flagged precipitation values are accumulated along with the presumably good values. Experience shows that the month-accumulated values should be discarded when accumulated FA exceeds 20%, or the 5x5-grid-box-average accumulated FA exceeds 10%, or the grid box has fewer than 60% of the nominal number of samples for the month at the box's latitude. The resulting holes in the coefficient field are smooth-filled from surrounding grid boxes. In some cases, such as January in Eurasia, these fill-ins can be quite extensive. As a result, our confidence in VAR over wintertime land is reduced.
3. In the combination of HQ and VAR (3B42RT), the HQ values previously judged to be suspect are set to missing before combination with VAR.

....

The dominant **IR data correction** is for slanted paths through the atmosphere. Referred to as "limb darkening correction" in polar-orbit data, or "zenith-angle correction" (Joyce et al. 2001) in geosynchronous-orbit data, this correction accounts for the fact that a slanted path through the atmosphere increases the chances that (cold) cloud sides will be viewed, rather than (warm) surface, and raises the altitude dominating the atmospheric emission signal (almost always lowering the equivalent Tb). The slant path also creates an offset to the geolocation of the IR pixel due to parallax. That is, the elevated cloud top, viewed from an angle, is located closer to the satellite than where the line of sight intersects the Earth's surface. Pixels are moved according to a standard height-Tb-zenith angle profile, at the price of holes created when tall clouds are moved further than shallow clouds behind them. In addition, the various sensors have a variety of sensitivities to the IR spectrum, usually including the 10-11 micron band. Inter-satellite calibration differences are documented, but they are not implemented in the current version. They are planned for a future release. The VAR largely corrects inter-satellite calibration, except for small effects at boundaries between satellites. The satellite operators are responsible for detecting and eliminating navigation and telemetry errors.

....

A number of **known errors** are contained in part or all of the current 3B42 archive. They have been uncovered by visual inspection and other diagnostics, but correction awaits the next reprocessing. Other items will be included in future re-processing cycles as possible. For ease of document maintenance, some of the following items imply the known error by stating what upgrade was applied.

1. NESDIS AMSU-B estimates are deficient in sensing light precipitation, leading to an underestimate that is regionally dependent, but nears 100% in light-rain areas. Because of this, the AMSU-B estimates are used only if no other HQ estimates are available, meaning that the AMSU-B's deficiency is minimized in the TMPA. Nonetheless, it causes as much as a 10% bias in the zone 30°N-S over oceans. As well, the AMSU-B record used in the (frozen) Version 6 data set has a time-varying effect, being absent before 2000, phasing in over the next two years, changing to a new, even sparser set of estimates in late August 2003, then upgrading to a better estimator in late May 2007.
2. The CAMS gauge analyses introduce a slight negative bias over land, compared to the GPCC analysis. GPCC is used through April 2005 and CAMS thereafter.

....

Two **known anomalies** exist in the data sets.

1. For the period January 1, 1998 - February 6, 2000, 1°, 3-hourly histograms of IR data were used in the 3B42 processing. This data only covers the region 40°N-S, so the latitude bands 40-50° in each hemisphere contain only HQ estimates. After February 6, 2000, the 4-km IR is used, which covers the entire region 50°N-S.
2. The TRMM orbital altitude was raised from 350 to 401.5 km in August 2001 to extend the life of the mission by reducing the amount of fuel needed to maintain the orbit. This caused small changes in footprint size and minimum detectable precipitation rates. The Version 6 algorithms are supposed to account for these changes, but tests show small unavoidable differences that are still being researched.

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10. Missing Value Estimation and Codes

There is generally no effort to **estimate missing values** in the single-source input data sets.

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All products in the TMPA use the **standard missing value** "-9999.9".
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All **missing hours** of a product result from completely absent input data for the given hour. If the input file(s) is(are) available, the product file is created, even if it lacks any valid data.
....

11. Quality and Confidence Estimates

The **accuracy** of the precipitation products can be broken into systematic departures from the true answer (bias) and random fluctuations about the true answer (sampling), as discussed in Huffman (1997). The former are the biggest problem for climatological averages, since they will not average out. However, for short averaging periods the low number of samples and/or algorithmic inaccuracies tend to present a more serious problem for individual microwave data sets. That is, the sampling is spotty enough that the collection of values over, say, one day may not be representative of the true distribution of precipitation over the day. For VAR, the sampling is good, but the algorithm likely has substantial RMS error due to the weak physical connection between IR Tb's and precipitation.

Accordingly, the "random error" is assumed to be dominant, and estimates could be computed as discussed in Huffman (1997). Random error cannot be corrected.

The "bias error" is likely small, or at least contained. This is less true over land, where the lower-frequency microwave channels are not useful for precipitation estimation with our current state of knowledge. The state of the art at the monthly scale is reflected in the study by Smith et al. (2006). Studies of the sub-monthly bias have not yet been performed.
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The TMPA **intercomparison results** are still being developed. The time series of the global images shows good continuity in time and space across the geo-IR data boundaries. Overall, the analysis approach appears to be working as expected. See Huffman et al. (2007) for more information.

Early validation studies are being conducted under the auspices of the International Precipitation Working Group in Australia, the continental U.S. and western Europe. Respectively, the web sites for these activities are:

http://www.bom.gov.au/bmrc/SatRainVal/sat_val_aus.html
http://www.cpc.ncep.noaa.gov/products/janowiak/us_web.shtml
http://kermit.bham.ac.uk/~ipwgeu/
....

12. Data Archives

The **archive and distribution site** for the official release of the TRMM Multi-Satellite Precipitation Analysis is:

Goddard Earth Sciences Data and Information Services Center
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA
Phone: +1-301-614-5224
Fax: +1-301-614-5268
Internet: *help-disc@listserv.gsfc.nasa.gov*
Web site: *http://disc.gsfc.nasa.gov*

Interactive Web-based access to the data and related fields is provided through TOVAS; see that topic for details.

Independent archive and distribution sites exist for the input data sets, and contact information may be obtained through Dr. Huffman (see "Documentation creator").
....

13. Documentation

The **documentation creator** is:

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....

The **documentation revision history** is:

22 October 2007	Version 1	by GJH, DTB
28 December 2007	Rev. 1.1	by GJH
26 February 2008	Rev. 1.2	by GJH
08 September 2009	Rev. 1.3	by GJH

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TMPA data format and toolkit: *http://tsdis.gsfc.nasa.gov/tsdis/Documents/Tutorial.pdf*
TMPA paper: ftp*://meso.gsfc.nasa.gov/agnes/huffman/papers/TMPA_jhm_07.pdf.gz*
TOVAS: *http://disc2.nascom.nasa.gov/Giovanni/tovas/*
TRMM home: *http://trmm.gsfc.nasa.gov/*
....

14. Inventories

The **data set inventory** may be obtained by accessing the 3B42 and 3B43 product listings at *http://mirador.gsfc.nasa.gov/cgi-bin/mirador/presentNavigation.pl?tree=project*

&project=TRMM&dataGroup=Gridded&CGISESSID=d660bf019d3f9906573bde73378e537c
or by contacting the representative listed in section 12.
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15. How to Order Data and Obtain Information about the Data

Users interested in **obtaining data** should access the 3B42 and 3B43 product listings at *http://mirador.gsfc.nasa.gov/cgi-bin/mirador/presentNavigation.pl?tree=project &project=TRMM&dataGroup=Gridded&CGISESSID=d660bf019d3f9906573bde73378e537c*or by contacting the representative listed in section 12.

As well, Web-based interactive access to the TMPA and related data is provided by TOVAS; see that topic for details.
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The **data access policy** is "freely available" with three common-sense caveats:

1. The data set source should be acknowledged when the data are used. [One possible wording is: "The TMPA data were provided by the NASA/Goddard Space Flight Center's Laboratory for Atmospheres and TSDIS, which develop and compute the TMPA as a contribution to TRMM."]
2. New users should obtain their own current, clean copy, rather than taking a version from a third party that might be damaged or out of date.
3. Errors and difficulties in the dataset should be reported to the dataset creators.

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